COMMENTS ON PRESENTATION BY PAUL COX

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As the first discussant, my main concern will be with what I consider the the most important aspect of this problem. It involves the question of the basic underlying model and what the purposes of the investigator were in designing this experiment. As our chairman has just pointed out, this is our primary consideration.

This example illustrates what I think is a truism in statistical design and experimentation, viz. that no amount of statistical knowledge and methodology, however great, is a sufficient substitute of substantive knowlege of the field of application and in being able to discuss with the investigator the important questions. For instance, Mr. Cox has indicated that his six points were arbitrarily selected and the analysis of variances relating thereto were not necessarily meaningful. This may be so in these six points but does the person who has the expert knowledge of thrust curves tend to associate important meanings to them, or any other set of critical points. It may very well be that point A has direct application to the understanding of the model underlying thrust curves and that the actual value of A, the time elapsed from the origin, or the rate of ascent from the origin to A are of primary concern to the rocket motor designer.

This is best illustrated from examples in my own field of biology and medicine. We have similar kinds of data which may not be as closely continuous as the thrust curve, but the points of observation in the time series are spaced close enough together that we treat them as such. Thus, we have tracings for electrocardiograms, growth curves, and epidemic curves. In the electrocardiogram, the distance and regularity between two waves is extremely important to the cardiologist and deviations from normalcy are based upon this pattern. In an epidemic curve, we are interested in the length of time between peaks such as in the periodicity of measles. We are also interested in the amplitude of the waves in order to know expected numbers of cases.

In other words, without discussing with the engineer of the rocket motor thrust curve what his problem is, it is difficult for me to know how to handle best these data. It may be the measurement of the critical points, the length of time until each maximum is attained, or even the integral summing up the total amount of thrust.

If one is convinced that he does want to fit a mathematical equation to this curve, or segments of it, a nasty problem arises because of the time series nature of the data. The observations in time are not independent and the residuals may be autocorrelated. This is not a new problem. The econometricians have been considering this problem for years in their analysis of time series.

I might suggest one reference to Mr. Cox in this connection which may help in fitting equations to segments of the curve and the analysis thereof. A paper by Elston and Grizzle (Biometrics, Vol. 18, No. 2, June 1962, pp. 148-159.) considers the various ways of estimating time-response curves and the ideas in that paper should prove helpful in this problem.